भारतीय मानक
Indian Standard

IS 16362 : 2020

भूकृत्रिम — फुटपाथ संरचनाओं में सबग्रेड स्थिरीकरण में प्रयुक्त भूवस्त्रादि — विशिष्टि

(पहला पुनरीक्षण)

Geosynthetics — Geotextiles used in Subgrade Stabilization in Pavement Structures — Specification

(First Revision)

ICS 59.080.70

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Geosynthetics Sectional Committee, TXD 30

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Geosynthetics Sectional Committee had been approved by the Textile Division Council.

This standard was first published in the year 2015 and has now been revised to incorporate the following major changes:

a) Requirements for CBR puncture strength have been modified.
b) Requirements for burst strength, pullout interaction coefficient and coefficient of direct shear have been deleted.
c) References of Indian Standards have been updated.
d) BIS certification marking clause has been updated.

A large variety of detrimental factors, such as environmental conditions, subgrade conditions, traffic loading, utility cuts, road widening, ageing, etc contribute to distress in pavements which needs to be addressed in the maintenance or rehabilitation of the pavements. Pavement maintenance treatments are often ineffective and short lived due to their inability to both, treat the cause of the problem and renew the existing pavement condition. The main cause of distress in pavements is the inability of pavement materials to drain out precipitated surface water infiltrating through the pavement, leading to softening and weakening of pavement subgrade and base thus accelerating pavement degradation. Further, existing pavement distress, such as surface cracks, rocking joints and subgrade failures cause the rapid reflection of cracking up through the maintenance treatment.

The preferred strategy for long-term road and pavement performance should, therefore, be to build in safeguards during initial construction. These performance safeguards include stabilizing the subgrade against moisture intrusion and associated weakening; strengthening road based aggregate with efficient drainage of infiltrated water; and, as a last resort, enhancing the stress absorption and moisture proofing capabilities of selected maintenance treatments.

The geogrids and the geotextiles are the most cost effective tools for safeguarding roads and pavements. Geosynthetics extend the service life of roads, increase their load-carrying capacity, and reduce rutting. For larger rut depths, more strain is induced in the geotextiles where the stiffness properties of geotextiles are essential. A considerable reduction in aggregate thickness is possible by the use of geotextiles having a high modulus in the direction perpendicular to the road centerline, however, the benefits of the geotextiles are dependent on the membrane action achieved with a stiff geotextiles as well as the lateral movement. The most common method for quantifying the geosynthetic benefits is the determination of Traffic Benefit Ratio (TBR) which is defined as the ratio of reinforced load cycles to failure (excessive rutting) to the number of cycles that cause failure of an unreinforced road section. In general, geosynthetics have been found to provide a TBR in the range of 1.5 to 70, depending on the type of geosynthetic, its location in the road, and the testing scenario. The researchers have found that for weak subgrades (CBR = 2 percent) the geotextile extends the service life of a flexible pavement section by a factor of 2.5 to 3.0 compared to a non-stabilized section. Further, a geotextile effectively increased the pavement section's total AASHTO structural number by approximately 19 percent. Similarly, for pavement sections with moderate strengths (CBR = 4.2 to 4.5 percent), the geotextile increased the service life of the pavement section by a factor of 2.0 to 3.3 and the AASHTO structural number increased by 13 to 22 percent. Also, the benefit of inclusion of geosynthetic material is briefed with design methodologies in IRC SP 59 : 2019 'Guidelines for use of geosynthetics in road pavements and associated works (*first revision*)'. Both geotextiles and geogrids thus can play an important role in extending the life of a roadway system.

The four main applications of geosynthetics in roads are, subgrade separation, subgrade stabilization, base/subbase reinforcement and overlay stress absorption and sub-surface drainage. Subgrade stabilization and base reinforcement involve improving the road structure as it is constructed by inserting an appropriate geosynthetic layer. Base reinforcement is the use of geosynthetics to improve the structure of a paved road.

Subgrade separation and stabilization applies geosynthetics to both unpaved and paved roads. When serving as a separator, the geotextile prevents fines from migrating into the base course and/or prevents base course aggregate from penetrating into the subgrade. The soil retaining properties of the geotextile are basically the same as those required for drainage and filtration. Therefore, the retention and permeability criteria required for drainage should be met. In addition, the geotextile should withstand the stresses resulting from the load applied to the pavement. The nature of these stresses depends on the condition of the subgrade, type of construction equipment and the cover over the subgrade. Since, the geotextile serves to prevent aggregate from penetrating the subgrade, it shall meet puncture, burst, grab and tear strengths required. At small rut depth, the strain in the geosynthetic is also small. In this case, the geosynthetic acts primarily as a separator between the soft subgrade and the aggregate. Any geosynthetic that survives construction will work as a separator. This application is limited to soils which either in initially or seasonably have a CBR >3 but < 8. In this application the geotextile is a substitute for the choked subbase stone commonly used over plastic subgrades. It is important to understand that this function may be required when geogrids are used to provide base reinforcement or confinement.

Geotextiles for stabilization provide coincident functions of separation and filtration especially when these are used in wet and saturated conditions. In some installations, these can also provide the function of reinforcement. For very weak subgrades, it is often beneficial to combine the benefits of both separation and stabilization. The following general conclusion can be drawn relating to a typical road base:

a) A geosynthetic element that functions primarily as a separator (typically when the subgrade CBR > 3) will prevent the mixing of poor soils with granular materials of pavement (*separation geotextiles*). This will enhance the long term performance of pavement.

b) A geosynthetic element that functions primarily to provide confinement of the aggregate and lateral restraint to the subgrade (typically when the subgrade CBR < 3 or between 1 and 3) will both increase the allowable bearing capacity of the subgrade and provide an improved load distribution ratio in the aggregate. The combined benefits can enhance load carrying capacity of the road by well over 50 percent (*stabilization geogrids, geocells and geotextiles*).

The general rules for use of geogrids and geotextiles in roadway system are as follows:

a) *Temporary Roads* — Used for hauling and access roads that are subject to low volume of traffic including working platform for permanent road construction:

    1) *Clayey or silty subgrade with California Bearing Ratio (CBR) < 4* — If a clean base aggregate is used, then a non-woven separator geotextile shall be used. If a “choked aggregate” like general crusher run is used, then use either a geotextile or a biaxial geogrid that has good aperture stability and appropriate size. For a design equivalent single axle loading (ESAL) less than 1 000, a woven geotextile designed for both separation and membrane roles may be used; that is, consider the geotextile’s modulus. For larger ESAL, use a woven or non woven geotextile designed simply for separation. The reinforcement role of the geogrid seems safe for approximately 10 000 ESAL.

    2) *Sandy subgrade with CBR<3* — Select a biaxial geogrid with good aperture stability and appropriate size or, a woven geotextile that has a reasonable interface friction with the sand and the aggregate. If a woven geotextile is considered, care should be taken to ensure that it does not actually create a slick slip-plane beneath the aggregate, that is, look at the interface friction by using geotextiles with high surface roughness which leads to enhanced interface friction.

b) *Permanent Roads (ESAL>200 000):*

    1) *Clayey or silty subgrade with CBR<3* — Consider building a working platform using the temporary road methods upon which conventional road can be constructed.

    2) *Clayey or silty subgrade with 3<CBR<8* — If there is any potential for degradation due to water intrusion, frost heave, etc. then include a separator geotextile to protect the base aggregate during these periods.

    3) *Sandy subgrades with CBR<3* — Use a biaxial geogrid that has good aperture stability and appropriate size to reinforce the base aggregate. This is particularly helpful when poor quality stone and small aggregate thickness is used, less than 25 cm.

Geosynthetics can also be used as inter layers by placing them below or within the overlay (asphalt concrete) and are thus helpful in rehabilitating distressed road surfaces. These may also provide a moisture barrier.

Survivability of geotextiles is very important from the viewpoint of their long-term durability and is defined as the resistance to mechanical damage during road construction and initial operation. The ability of a geosynthetic to survive installation and reasonable service loads shall be assured if it is to perform as designed. Installation damage to a geotextile is a function of the following:

a) Geotextile thickness;

b) Compactive effort and lift thickness;

c) Type and weight of construction equipment used for fill spreading;

d) Grain size distribution of backfill;
e) Angularity of backfill;
f) Polymer used in the manufacture of geotextile; and
g) Geotextile manufacturing process.

Geotexiles are mainly made from polyester (PET) or polypropylene (PP). PP is lighter than water, strong and very durable. PET is heavier than water, has excellent strength and creep properties, and is compatible with most common soil environments. Geotextiles are mainly of two types, namely, woven and non-woven geotextiles. Knitted and stitch bonded geotextiles are occasionally used in the manufacture of specialty products. Non-woven geotextiles are highly desirable for subsurface in planer drainage, and erosion control applications as well as, for road stabilization over wet moisture sensitive soils. Out of woven geotextiles, slit film fabrics geotextiles are commonly used for sediment control, that is silt fence and road stabilization applications but are poor choices for subsurface drainage and erosion control applications. Monofilament woven geotextiles have better permeability making them suitable for certain drainage and erosion control applications. High strength multifilament woven geotextiles are primarily used in reinforcement applications.

The committee has reviewed the provisions of the following International Standard referred in this standard and has decided that it is acceptable for use in conjunction with this standard:

International Standard	*Title*
ISO 10722 : 2019	Geosynthetics — Index test procedure for the evaluation of mechanical damage under repeated loading — Damage caused by granular material (Laboratory test method)

The composition of the Committee responsible for the formulation of this standard is given in Annex C.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 ‘Rules for rounding off numerical values (*revised*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

GEOSYNTHETICS — GEOTEXTILES USED IN SUBGRADE STABILIZATION IN PAVEMENT STRUCTURES — SPECIFICATION

(First Revision)

1 SCOPE

1.1 This standard covers general and performance requirements for geotextiles used in wet and saturated soil conditions to provide the subgrade stabilization in pavement structures along with coincident functions of separation and filtration. In some installations, the geotextile can also provide the functions of reinforcement.

1.2 The stabilization function of geotextile is applicable to pavement structures constructed over existing subgrade soils with a California Bearing Ratio between 1 and 3 (1 < CBR < 3), and shear strength between approximately 30 to 90 kPa. The stabilization application is appropriate for subgrade soils which are saturated due to a high ground water table or due to prolonged periods of wet weather.

1.3 This standard is not suitable for embankment reinforcement where stress conditions may cause global subgrade foundation or stability failure.

NOTES:

1 The function of stabilization in this application refers to including a tensile member in the form of a geotextile between the aggregate cover material and the soft subgrade soil with the intent of either increasing the structural support capacity of that component of the pavement structure and hence its life or reduce the initial cost. The geotextile may also serve to stabilize the sub-grade provided the geotextile conforms to the requirements for separation and filtration as prescribed in relevant specifications..

2 The design of geosynthetic-reinforced unpaved roadways has been simplified into design charts that relate aggregate thickness requirements to a range of subgrade strengths, based on standard highway design loading and various allowable rut depths.

3 This is a material purchasing standard and design review of its use for intended applications is recommended. This is not a construction or design standard. Stabilization of the pavement section is a site specific design issue which should be addressed by the engineers responsible for the pavement and embankment design. This standard is not appropriate for embankment reinforcement where stress conditions may cause global subgrade foundation or embankment failure. Design details for geotextile for stabilization, such as geotextile type, cover material thickness, pavement cross-section and associated details, shall be as shown on the contract drawings.

4 This standard is based on the minimum requirements of the geotextile to provide tensile reinforcement and survivability from installation stress. The physical properties listed in Table 1 are applicable for a minimum backfill thickness of 150 mm. However, in general, the geotextile shall be placed at the proper elevation, location and orientation as detailed on the plans and specification. Unless otherwise specified in the project specification, the contractor shall follow the construction/installation guidelines in the relevant Indian Standard.

2 REFERENCES

The standards listed in Annex A contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

3 DEFINITIONS

For the purpose of this standard, the definitions as given in IS 13321 (Part 1) and the following shall apply.

3.1 Minimum Average Roll Value (MARV) — The average value of roll minus two times the standard deviation. Statistically, it yields a 97.7 percent degree of confidence that any sample taken during quality assurance testing will exceed value reported.

3.2 Subgrade Improvement — It is defined as the improvement of the bearing capacity and mitigation of deformation of the subgrade soil by placing a geotextile immediately over a soft subgrade soil. The goal of this application may be to reduce undercut requirements, improve construction efficiency, reduce the amount of aggregate subbase/base material required, provide a stiff working platform for pavement construction, or combination of these.

3.3 Traffic Benefit Ratio (TBR) — It is also known as traffic improvement factor or (TIF) and is defined as the ratio of reinforced load cycles to failure (excessive rutting) to the number of cycles that cause failure of an unreinforced road section. Thus it compares the performance of a pavement cross-section with a geotextile-reinforced base course to a similar cross-section without geotextile reinforcement, based on the number of cycles to failure. The failure is defined as a selected depth of rut through repetitive loading applied by a passing wheel load of at least 2041.2 kg per single wheel or 4082.4 kg per dual wheel.

4 REQUIREMENTS

4.1 Geosynthetic materials shall be inert to commonly encountered chemicals, resistant to rot and mildew, and shall have no tears or defects which adversely affect or alter its physical properties. Materials required for complete and proper installation of geosynthetic materials that are not specifically described herein, (such as pins, nails, washers, etc) shall conform to the manufacturer's recommendations and be as selected and supplied by the contractor subject to final approval by the engineer.

4.2 Polymers used in the manufacture of geotextiles, and the mechanical fasteners or threads used to join adjacent rolls, shall consist of long chain synthetic polymers, composed of at least 95 percent by weight of polyolefins (polyethylene or polypropylene) or polyesters when tested as per dissolution method in respective solvents as specified in IS 667. They shall be formed into a stable network such that the ribs, filaments or yarns retain their dimensional stability relative to each other, including selvedges. Polyolefin material shall be made resistant to ultraviolet light by adding 2 to 3 percent carbon black. Recycled polymers shall not be used in the manufacture of geotextiles and only virgin polymers shall be used for manufacture. In case of polyester geotextiles, the isophthalic acid content of the virgin polyester shall be nil when tested according to the method prescribed in Annex B.

4.3 Geotextiles shall be dimensionally stable and able to retain their geometry under manufacture, transport, and installation. Woven slit film geotextiles (that is, geotextiles made from yarns of a flat, tape-like character) shall not be allowed. Geotextiles used for stabilization of pavement structure shall conform to the physical requirements as specified in Table 1. Average of test results from any sampled roll in a lot shall meet or exceed the minimum values specified in Table 1.

NOTES:

1 All numeric values in Table 1 except Apparent Opening Size (AOS), represent MARV in the weakest principal direction. Values for AOS represent maximum average roll values.

2 The property values in Table 1 represent default values which provide for sufficient geotextile reinforcement and survivability under most construction conditions.

5 SAMPLING AND CRITERIA FOR CONFORMITY

5.1 Lot

The quantity of the same class of geotextile manufactured from the same polymer under identical conditions and supplied to a buyer against one dispatch note shall constitute a lot.

5.2 Sampling for tests shall be done in accordance with IS 14706 from each lot. Acceptance shall be based on testing of conformance samples obtained using the procedure given in IS 14706.

5.3 Testing of samples shall be performed in accordance with the methods referred to in this standard for the indicated requirement(s). The number of test specimens shall be as specified in each test method. Product acceptance shall be determined by comparing the average test results of all the specimens within a given sample to the specified MARV.

5.4 Criteria for Conformity

The geotextile shall be tested for all the requirements as specified in Table 1 and **4.1** to **4.3** of this standard. When any individual sample fails to meet any standard requirement, that roll shall be rejected and two additional sample rolls shall be selected from the same lot. The lot shall be declared conforming to the requirements of this standard if neither of these two additional samples fails to comply with any part of this standard, otherwise the entire quantity of rolls represented by that sample shall be rejected.

6 MARKING AND LABELLING

6.1 The geotextile material shall be marked with the following by attaching the printed labels:

a) Identification of the geotextile material as per manufacturer's recommendation, for example, polyester multifilament woven geotextile for stabilization in pavement structures;
b) Class of geotextile material that is Class 1 or Class 2;
c) Batch number, lot number and roll number;
d) Date of manufacture of geotextile material;
e) Any other information/instruction prescribed by the manufacturer or by the law in force;
f) Manufacturer's name, initials or trade-mark; and
g) The country of origin.

6.2 BIS Certification Marking

The geotextile conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the geotextile may be marked with the Standard Mark.

7 PACKING

The geotextile shall be packed in rolls or as per the contract or order. Each roll or package shall be protected by wrapping it in a LDPE film of minimum thickness of 40 microns to prevent it from the adverse impact of heat and moisture, oil, grease, dirt, dust and other stains during shipment and storage prior to deployment.

Table 1 Requirements of Geotextiles for Stabilization Applications

(*Clauses* 4.3 *and* 5.4)

Sl No.	**Characteristic(s)**	**Requirement(s)**						**Method of Test, Ref to**
		Class 1		Class 2		Class 3		
		Elongation < 50 percent	Elongation ≥ 50 percent	Elongation < 50 percent	Elongation ≥ 50 percent	Elongation < 50 percent	Elongation ≥ 50 percent	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
A Index Properties								
i)	Type of geotextile	← Woven/non-woven →		← Woven/non-woven →		← Woven/non-woven →		—
ii)	Roll length, m, *Min*	← 50 or 100 or as agreed →		← 50 or 100 or as agreed →		← 50 or 100 or as agreed →		IS 1954
iii)	Roll width, m, *Min*	← 2.0 or 5.0 or as agreed →		← 2.0 or 5.0 or as agreed →		← 2.0 or 5.0 or as agreed →		IS 1954
iv)	Grab strength, N, *Min*	1 400	900	1 100	700	800	500	IS 16342
v)	Sewn seam strength, N, *Min*	1 200	810	990	630	720	450	IS 15060
vi)	Trapezidal tear strength, N, *Min*	500	350	400	250	300	180	IS 14293
vii)	CBR puncture strength, N, *Min*	2 800	2 000	2 200	1 400	1 700	1 000	IS 16078
B Structural Integrity Properties								
i)	Permittivity, sec^{-1}, *Min*	0.05	0.05	0.05	0.05	0.05	0.05	IS 14324
ii)	Apparent opening size (AOS), mm, *Max*	0.43	0.43	0.43	0.43	0.43	0.43	IS 14294
C Durability Properties								
i)	Resistance to installation damage, percent retained strength, SC/SW/GP (*see* note 5), *Min*	← 95/93/90 →		← 95/93/90 →		← 95/93/90 →		ISO 10722
ii)	Ultraviolet stability at 500h, retained strength, percent of original strength, *Min*	70	—	70	—	70	—	IS 13162 (Part 2)

NOTES:

1 Resistance to installation damage (loss of load capacity or structural integrity) when subjected to mechanical installation stress in clayey sand (SC), well graded sand (SW) and crushed stone classified as poorly graded gravel (GP).

2 Class 2 or Class 3 geotextile may be specified in view of the sufficient survivability based on field experience, laboratory testing and visual inspection of a geotextile sample removed from a field test section.

3 Permittivity and permeability of geotextile should be greater than that of the soil.

4 For Class 2, the required MARV tear strength for woven monofilament geotextiles shall be 250 N.

8 INFORMATION AND SAMPLES TO BE SUBMITTED BY THE MANUFACTURER

The manufacturer shall submit to the purchaser the following:

a) Geotextile product sample approximately one square metre or larger;

b) Geotextile product data sheet and certification from himself or by third party certification, such as the use of the Standard Mark stating that the geotextile product supplied meets the requirements of this standard; and

c) Manufacturer’s installation instructions and general recommendations.

9 STORAGE AND PROTECTION

9.1 During storage, elevate the geotextile rolls off the ground and adequately protect them from the following:

a) Site construction damage;

b) Excessive precipitation;

c) Extended exposure to sunlight;

d) Aggressive chemicals;

e) Flames or temperatures in excess of 71°C;

f) Excessive mud, wet concrete, epoxy, or other deleterious materials coming in contact with and affixing to the geotextile material; and

g) Any other environmental condition that may damage the physical property values of reinforcement.

9.2 Lay the rolled materials flat or vertical on ends.

9.3 Do not leave the geotextile material directly exposed to sunlight for a period longer than the period recommended by the manufacturer.

9.4 Each geotextile roll shall be wrapped with a material that will protect it from damage due to shipment, water, sunlight and contaminants.

9.5 Keep geotextile dry until installation, and do not store directly on the ground.

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
667 : 1981	Methods for identification of textile fibres (*first revision*)
1954 : 1990	Determination of length and width of woven fabrics — Methods (*second revision*)
13162 (Part 2) : 1991	Geotextiles — Methods of test: Part 2 Determination of resistance to the exposure of ultraviolet light and water (Xenon-arc type apparatus)
13321 (Part 1) : 1992	Glossary of terms for geosynthetics: Part 1 Terms used in materials and properties
14293 : 1995	Geotextiles — Method of test for trapezoid tearing strength
14294 : 1995	Geotextiles — Method for determination of apparent opening size by dry sieving technique
14324 : 1995	Geotextiles — Methods of test for determination of water permeability-permittivity
14706 : 1999	Geotextiles — Sampling and preparation of test specimens
15060 : 2018	Geotextiles — Tensile test for joints/seams by wide-width method
16078 : 2013	Geosynthetics — Static puncture test (CBR test)
16342 : 2015	Geosynthetics — Method of test for grab breaking load and elongation of geotextiles

ANNEX B

(*Clause* 4.2)

METHOD OF TEST FOR ISOPHTHALIC ACID CONTENT OF THE VIRGIN POLYESTER FIBRE

B-1 PRINCIPLE

This method is applicable to measure isophthalic acid content in polyethylene terephthalate sample. The polymer sample is digested in benzyl alcohol, depolymerized then esterified to dibenzyl isophthalate, dibenzyl terephthalate and glycol's. Isopropyl titanate is added as a depolymerization catalyst. The sample is analyzed by gas chromatography and the peak areas of the two esters are used to estimate the weight percentage dimethyl isophthalate using an internal standard.

B-2 POTENTIAL ENVIORMENT ISSUE

B-2.1 In case of spillage, it can lead to pollution near the workplace area and environment hazard. After analysis sample is disposed as per laid down procedure.

B-2.2 Hydrogen, nitrogen and instrument air are used during analysis. The hydrogen gas has no adverse ecological effects are expected. Hydrogen does not contain any Class I or Class II ozone depleting chemicals. However, hydrogen is explosive. Gaseous nitrogen is an inert non-flammable gas. High concentration in air may cause deficiency of oxygen with the risk of unconsciousness and death. Chloroform in high concentration in air can kill most animals in few minutes.

B-3 POTENTIAL SAFETY, OCCUPATIONAL HEALTH ISSUES

B-3.1 Proper PPE's like safety goggles, apron, surgical hand gloves to be used.

B-3.2 Glassware is to be handled with care.

B-3.3 Leak check to be carried out while handling of gas cylinder.

B-3.4 Glassware is to be handled with care.

B-3.5 Inhalation of chloroform causes dilation pupils with reduced reaction to light as well as reduced intraocculat pressure, irritation of mucous membrane, conjunctiva. If contacted with skin and eyes cause irritation. Seek medical advice if inhaled.

B-3.6 Use leather hand gloves while handling hot apparatus and equipments.

B-4 APPARTUS

B-4.1 Gas Chromatograph (GC), with flame ionization detector.

B-4.2 Capillary Column, 60 m length and 0.53 mm ID MXT ® - 1

B-4.3 Dispensette or Pipette, 2 ml, 5 ml and 10 ml.

B-4.4 Volumetric Flask, 100 ml, 500 ml.

B-4.5 Beaker

B-4.6 Funnel

B-4.7 Flask, 50 ml.

B-4.8 Heating Mental, to maintain temperature of 250°C.

B-4.9 AR Grade Dimethyl Isopthalate (DMI)

B-4.10 AR Grade Benzyl Alcohol

B-4.11 AR Grade Chloroform

B-4.12 AR Grade Isopropyl Titnate

B-4.13 AR Grade Dimethyl Suburate

B-5 PREPARATION OF STANDARD SOLUTIONS

B-5.1 Stock Dibenzyl Suburate (Internal Standard) Solution

Take 1.0 ± 0.01 g of dimethyl suburate (DMS). Add 100 ml of benzyl alcohol and 6 to 7 drops of isopropyl titnate digest it for 2 h. Allow it to cool up to room temperature then make the volume to 500 ml by carefully rinsing the flask by isopropyl alcohol. Dimethyl suburate will get converted into dibenzyl suburate (DBS). Mark the stock solution as DBS per 2ml ≈ X·XXXX mg

B-5.2 Stock Dimethyl Isopthalate (DMI) Solution

Take 0.2 ± 0.01 g of dimethyl isopthalate (DMI). Add 40 ml of benzyl alcohol and 6 to 7 drops of isopropyl titnate digest it for 2 h. Allow it to cool up to room temperature then make the volume to 100 ml by carefully rinsing the flask by isopropyl alcohol. This will be converted to dibenzyl isopthalate (DBI). Mark the stock solution as DBI per 2 ml ≈ X·XXXX mg.

B-5.3 Standard Solution for Response Factor

Take 2 ml of solution prepared in **B-5.1** and 2 ml of solution prepared in **B-5.2**. Add 10 ml of chloroform.

B-5.4 2.0 Percent Standard IPA Stock Solution

Weigh out accurately 0.200 ± 0.005 g of pure DMI powder into round bottom flask, add 30 ml of benzyl alcohol and 3 drops of isopropyl titante, reflux the solution for 5 h reagent and dilute to 100 g by isopropyl alcohol, calculate actual DMI concentration by considering its purity and label the flask with actual weight taken. Consider this weight during calculation of IPA by GC.

B-5.5 2.0 Percent Standard IPA Solution for GC Injection

Take 2.0 ml IPA stock solution and add 2 ml internal standard (*see* **B-5.1**) and further add 10 ml of chloroform, same bottle to be labelled as 2.0 percent IPA inject 1 µl in GC.

B-6 CALIBRATION FOR PERFORMANCE CHECK – TWICE /MONTH WITH STANDARD CHIPS

B-7 ANALYTICAL PROCEDURE

Inject 1 µl of standard solution for response factor (*see* **B-5.3**) and calculate response factor. Inject 1 µl of 2 percent standard IPA solution. If value of 2.0 percent standard IPA solution is varying in the range of 0.01 percent, then there is no need for change in response factor. If there is deviation in value then rerun standard solution for response factor (*see* **B-5.3**). Weight 0.2 ± 0.02 g of chips into the round bottom flask. Add 2 ml of benzyl alcohol. Add 3 drops of isopropyl titanate. Digest the solution for 1 h. Allow it to cool up to room temperature. Add 10 ml of chloroform. Add 2 ml of internal standard solution that is solution prepared in **B-5.1** and shake vigorously. Inject 1 µl of sample solution into gas chromatograph.

B-8 CHROMATOGRAPH SETTINGS

Injector temperature	: 300°C
Detector temperature	: 320°C
Oven temperature	: 270°C

Gas flow rates

Nitrogen	: 20 psig
Hydrogen	: 30 ± 10 ml/min
Air	: 300 ± 20 ml/min
Attenuation	: - 4
Range	: 1

B-9 CALCULATION

$$\text{Response factor (RF)} = \frac{A_1 \times W_2}{A_2 \times W_1}$$

Where,

A_1 = Area of dibenzyl suburate (DBS) (Internal standard) solution;

W_1 = Weight of DBS in solution, in mg;

A_2 = Area of DBI in standard solution; and

W_2 = Weight of DBI in standard solution, in mg.

$$\text{Percent IPA} = \frac{\text{RF} \times \text{mg Internal Standard} \times \text{Area of IPA in sample} \times 100}{\text{Weight of sample, in mg} \times \text{Area of internal standard in sample}}$$

ANNEX C

(*Foreword*)

COMMITTEE COMPOSITION

Geosynthetics Sectional Committee, TXD 30

Organization	*Representative(s)*
The South India Textile Research Association Council, Coimbatore	Dr A. N. Desai (***Chairman***)
Ahmedabad Textile Industry’s Research Association, Ahmedabad	Shrimati Deepali Plawat Shri Jigar Dave (*Alternate*)
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